



## MEMORANDUM

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DATE: June 11, 1999

TO: Bill Fehring - URSGWC

SUBJECT: **Daniel Island Marine Terminal EIS & Permits**  
**Evaluation of Rail Access Alternative #7**  
**Cooper River & Clouter Creek Crossings**  
Proj. No. C100003353.01

FROM: George Patton, P.E.

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As requested, E. C. Driver & Associates, Inc. (ECDA) has reviewed the project requirements and issues for providing rail access for the Daniel Island Marine Terminal along Alignment Alternative #7 and offer the following discussion for your use in preparing the EIS and permits for the project.

### General

The proposed route for Alternative #7 has the rail extending from a point on the proposed marine terminal rail line, located north of Beresford Creek, to an existing rail line in North Charleston. The route would cross Clouter Creek, the U.S. Army Corps of Engineer's Clouter Creek Spoil Disposal Area and the Cooper River at a location immediately south of the Mark Clark Expressway.

As with the other project alternatives, the proposed line consists of a single-track carrying two-way traffic. The line is proposed to carry a maximum train configuration consisting of tandem Cooper E80 locomotives and one-hundred (100) double-stack container cars, each 65' in length with two axles and a weight of 95 tons. The proposed speed through the corridor is 25 mph. Maximum sustained grades on the rail line are to be limited to 0.5% with a maximum instantaneous grade of 1%.

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Movable spans will be required over Clouter Creek and the Cooper River because of navigation clearance requirements and the low rail grades. It is anticipated the rail line will be used up to eight (8) times per day. The movable spans will normally remain in the open position to least restrict marine traffic.

The proposed rail elevation immediately north of Beresford Creek is approximately +20'. The track elevation is maintained above the maximum flood elevations and minimizes the height of the proposed highway bridge that crosses the rail line near Beresford Creek.

### **Clouter Creek Crossing**

Clouter Creek is a navigable waterway with navigation requirements of 120' horizontal clearance and 75' vertical clearance.

The height of the bridge and corresponding vertical clearance is governed by the maximum sustained grade and available run. An estimated run of 7,000' between the highway bridge crossing near Beresford Creek and Clouter Creek is available to increase the vertical profile. With a maximum sustained grade of 0.5%, the maximum achievable rail elevation at Clouter Creek is approximately +55'. The estimated structure depth over the navigation channel is 14', assuming a deck girder configuration and a span length of 150'. With a mean high water elevation of approximately +6', the maximum vertical clearance with the span in the lowered (closed) position is 35'.

In order to provide a vertical clearance of 75', a movable span is required over the 120' navigation channel. Both single-leaf bascule and vertical-lift schemes are viable alternatives and are well within the range of practical application for the span length and operational requirements. A single-leaf bascule scheme can provide unlimited vertical clearance, however, this will not likely be required as an existing fixed highway bridge over Clouter Creek, immediately north of this proposed crossing, has a restricted vertical clearance of 75'. With this restricted clearance, a vertical-lift span with a required lift height of 40' can likely be permitted.

The raised track profile between Beresford Creek and Clouter Creek can be supported on an embankment fill or railroad trestle. In general, embankments are less costly than railroad trestle. However, as the rail alignment is located predominately over wetland areas and the embankments will be relatively high (40' to 50'), there are concerns with potential roadbed settlements associated with consolidation of existing underlying soft and/or organic soils caused by the additional overburden from the embankment material. Removal of the these soft and/or organic soils and or the application of soil reinforcing or stabilization techniques may be required to avoid significant future maintenance efforts (e.g., track lifting) and will significantly add to the cost of the embankment construction.

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In addition, the embankments will introduce large slopes and drainage systems that will have to be maintained. Because of the length and height of the proposed embankments, a great deal of fill would be required for this construction. It is unknown whether suitable borrow pits are locally available of the size required for this construction. Thus, if the fill must be imported, the embankment costs will be higher.

#### **Clouter Creek Spoil Disposal Area**

The area bounded by the Cooper River to the west and Clouter Creek to the east along this alignment has been identified by the U. S. Army Corps of Engineers for use as a spoil disposal area. The disposal area is ultimately to be filled to an elevation of +50' throughout the site. The track elevation can be constructed at or above elevation +55' throughout this area and thus would be above the spoil disposal.

As with the elevated rail line approaching Clouter Creek, the raised track profile can be supported on an embankment fill or railroad trestle. However, there are concerns with supporting the rail line on both of these schemes. Issues similar to those discussed above for the embankments approaching Clouter Creek will also be present for a high embankment over the disposal area (e.g., roadbed settlements, limited availability of suitable borrow material, large slopes and drainage systems to maintain, etc). It is unlikely, the spoil material will have the required material properties to use in the embankment fill. In addition, the embankment is likely to displace a significant volume of the disposal area (i.e., the width at the base for a 50' high embankment is approximately 175' and could be wider depending on the height of the embankment, the quality of the available borrow material and required fill compaction.)

If railroad trestle is used in lieu of embankment fill, spoil disposal material placed around the pilings of the trestle structure will introduce significant downdrag forces in the piles that must be accounted for in the design. In lieu of designing for these large forces, the spoil disposal material can be eliminated from around the trestle. This however, would split the disposal area and introduce additional slopes and drainage systems that would have to be maintained and displace a significant volume of disposal material.

#### **Cooper River Crossing**

The Cooper River is a major navigable waterway with navigation requirements of 700' horizontal clearance and 155' vertical clearance.

As with the Clouter Creek crossing, the height of the bridge and corresponding vertical clearance is governed by the maximum sustained grade and available run. If the 0.5% grade for the rail line is maintained for the additional 7,000' run available between Clouter

Creek and the Cooper River, the track can achieve a maximum elevation of approximately +90' at the Cooper River navigation channel. The estimated structure depth below the top of rails is 9', assuming a through truss configuration and a span length of 750'. With a mean high water elevation of approximately +6', the maximum vertical clearance with the span in the lowered (closed) position is 75'. If the +55' track elevation required above the spoil disposal area is maintained across the Cooper River, the vertical clearance over the navigation channel with the bridge lowered (closed) will be limited to 40'.

In order to provide a vertical clearance of 155', a movable span is required over the 700' navigation channel. Vertical-lift span and double-swing span schemes provide the most practical configurations for a movable span of this significant length. However, the 750' span length required poses significant engineering challenges as it introduces dimensions well in excess of world record lengths for a movable span (i.e., the longest vertical-lift span in the world is less than 600' in length and the longest double swing span is less than 500'.) The challenge is complicated further with the possibility of significant seismic events. As the movable span is to be normally maintained in the raised (open) position, restraint of the movable span under seismic movements becomes a much more difficult task, especially when considering the large mass and proportions of the span.

A double-swing span scheme can provide unlimited vertical clearance, however, this will not likely be required as an existing fixed highway bridge over Cooper River (i.e., the Mark Clark Expressway), immediately north of this proposed crossing, has a restricted vertical clearance of 155'. With this restricted clearance, a vertical-lift span can likely be permitted. A lift height of 80' is required where the vertical clearance in the lowered (closed) position is 75' and a lift height of 115' is required where the vertical clearance in the lowered (closed) position is only 40'.

The lift span is more commonly used for long movable span railroad bridges largely because of the simple span configuration. The double-swing scheme requires a undesirable mid-span joint.

The main pier substructure and foundations are likely to be of substantial construction when accounting for the possibilities of seismic events and vessel collision, the influences of scour and the likelihood of deep foundations within the river. The main piers must also account for the large mass of the lift span and/or counterweights and must have greater stiffness to ensure reliable span operation. The foundations for a double-swing span scheme are likely to be less substantial than the vertical lift-span scheme as the movable span will normally rest at track level unlike the vertical-lift which will normally be secured in a raised position well above track level. The savings will be offset somewhat by the additional pier protection required to prevent vessels from impacting the opened swing span superstructure.

The proximity of the Beresford Creek Bridge, Clouter Creek Bridge and Cooper River Bridge is such that the operation of these movable spans must be closely coordinated. In order to minimize the time the navigation channels will be closed to marine traffic, none of the movable spans should be lowered unless all three waterways are cleared of marine traffic. Otherwise, the train may stop on one movable span waiting for one of the other spans to open, thus unnecessarily closing that waterway for a longer period of time. As the span lowering is dependent on three waterways, the likelihood there will be delays for the train is much greater. The required coordination also complicates the sequencing of the track wayside signals and increases the potential for a mishap. Each span may be raised independently after the train is cleared to minimize the waterway closure.

The anticipated maximum cycle time for the movable spans, based on the proposed speed of 25 mph and the maximum train configuration of 6,500 ft., is approximately 21.0 minutes. This cycle time considers the lead time required to lower and secure the spans in the closed position, so that the train is not required to slow or stop as it approaches the bridge. The cycle time also considers the time to clear the train and time to raise and secure the bridge in the open position. The time is approximately the same for each of the movable spans and is approximately the same for the various movable span types.

The approach piers must similarly account for the possibilities of seismic events and vessel collision, the influences of scour and likelihood of deep foundations. As such, foundations and piers are likely to be costly and optimal span lengths are likely to be longer than those traditionally used on rail bridges.

#### **North Charleston Rail Connection**

West of the Cooper River the rail line will have to descend to connect with the at-grade rail lines in North Charleston. The required length of run is similar to the 14,000' of run required on the east side of the Cooper River. As such, the rail line will have to be constructed on a long embankment fill or railroad trestle structure.

There is a network of rail lines and roads (including the Mark Clark Expressway) on the west side of the Cooper River that will have to be crossed. If the rail is built on embankment, openings at each of the rail lines or roadways will be required. The openings can consist of tunnels through the embankment or cuts in the embankment with railroad trestle spanning the opening.

As with the embankments on the east side of the Cooper River, although the embankment fill is typically less costly than railroad trestle, there are concerns with the potential for settlement of the embankment fill, large embankments and drainage systems to maintain and uncertainties with the availability of large quantities of suitable borrow material.

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**Conceptual Cost Estimates**

The cost to carry the rail line from Beresford Creek, across Clouter Creek, the Clouter Creek Disposal Area and the Cooper River, for connection to the rail lines in North Charleston is estimated at \$235 Million. This estimate includes the following:

Trestle Structure (25,000 L.F.)	\$100,000,000
Clouter Creek Bridge	\$ 10,000,000
Cooper River Bridge	<u>\$125,000,000</u>
TOTAL	\$235,000,000

The costs were developed on a conceptual basis without detailed geotechnical information, site surveys, hydraulic data, seismic response data, information on local material availability, and environmental and socioeconomic considerations. In addition, the costs are for construction of the rail bridge only (i.e., track, superstructure, substructure and foundations) and does not include costs for such items as right-of-way, maintenance roads, miscellaneous structures (e.g., maintenance buildings, drainage structures, etc.) The costs do not include costs for design, construction engineering and inspection, or administration.